Pan-London IV Medication Administration Critical Care Competency

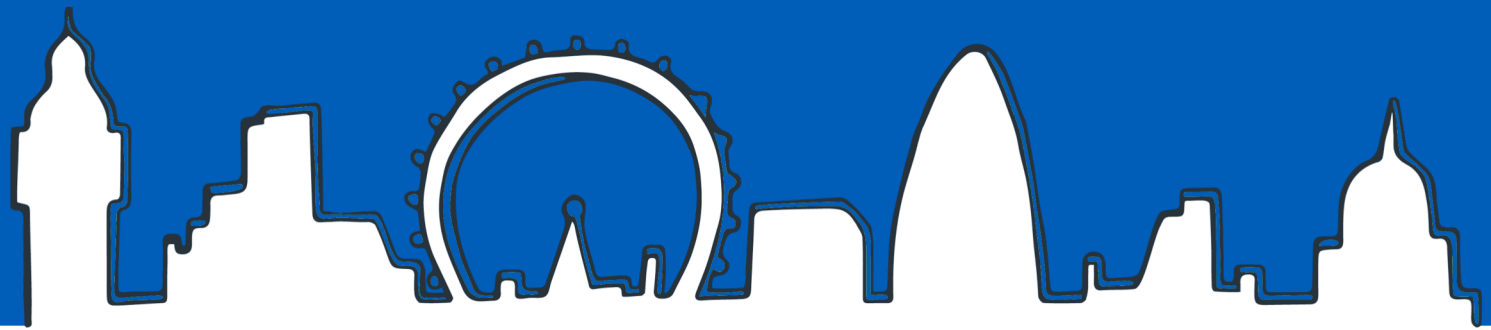
Educational resource

CapitalNurse is jointly sponsored by Health Education England, NHS England and NHS Improvement

Preface

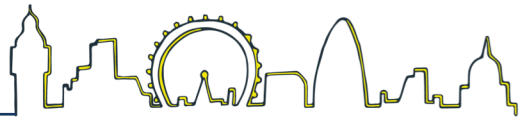
- This document is intended to be used as an educational resource when working to pass the Pan-London Critical Care IV Competency
- It is not intended as prescribing advice.
- It is not comprehensive on any topic – it is intended as a brief guide to some safety points.
- It is not intended to overrule local policies.
- Nothing in this document removes the need for individual patient assessment and clinical judgement.

Intravenous Vasoactive medication



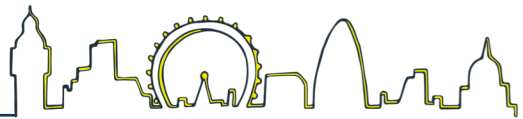
Intravenous vasoactive medication

- Inotropes and vasopressors are used to support or enhance blood flow and organ perfusion
- Inotropes increase cardiac contractility, vasopressors cause vasoconstriction (the term ‘inotropes’ is often used inaccurately to refer to vasopressors as well).
- Vasodilators and beta-blockers are used for the treatment of hypertension
- IV infusions of vasoactive drugs should only be used in areas with continuous monitoring and appropriate numbers of trained staff



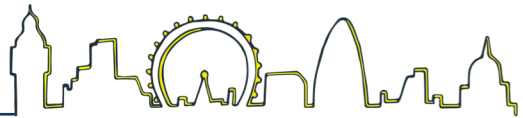
Half-life

- Half-life is a complicated concept, and there are different ways to define it
- The most straightforward way to think of it is the time taken for the effect of a drug to halve
- After 4.5 – 5 half-lives the effect of a drug is negligible
- It's important for a number of medications in critical care, for instance noradrenaline, which has an extremely short half life (2-3 minutes) – this has vital safety implications



Safety for a patient with IV vasoactive medications

- Administer through appropriate access – almost always a central line.
- Use a dedicated, labelled, lumen to avoid issues with compatibility and inadvertent bolus administration (some CCUs prefer the distal lumen).
- Compatibility is not just about chemical compatibility, also consider the action of the medicine.
- Target, e.g. MAP, must be clearly stated for titrating
- Assess peripheral circulation with vasopressors.



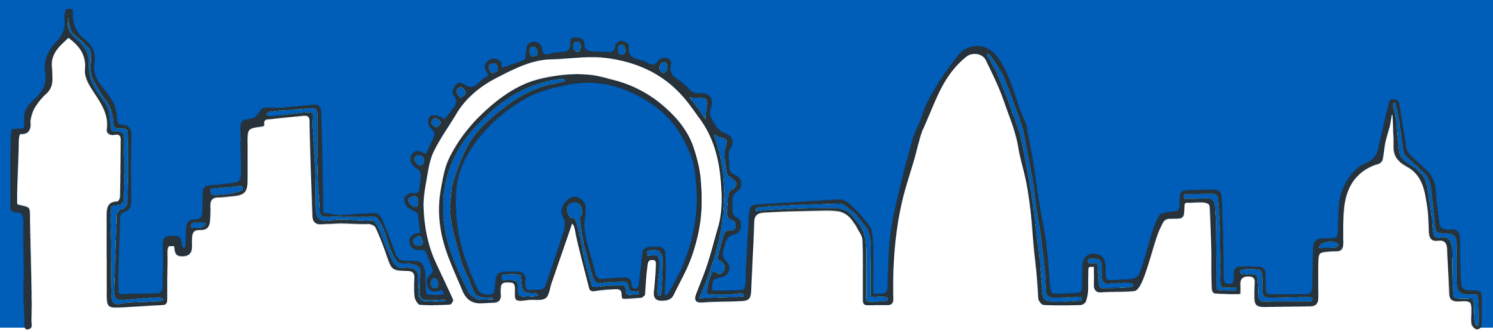
Safety, continued

- Understand the procedure for ‘double pumping’ if required (see Rutledge, 2013)
- Understand the considerations when changing the concentration of a vasoactive medicine
- Understand the process of titrating vasoactive medication to effect
- Troubleshooting: (see Rutledge, 2013)
  - Actions to be taken if alterations in blood pressure occur
  - Action to be taken for accidental line removal

Bibliography

- Rutledge K (2013) Titration of inotropes and vasopressors (chapter 7); Critical Care Manual of Clinical Procedures and Competencies, Mallett J, Albarran JW, Richardson A (eds)
- VanValkinburgh D; J. McGuigan JJ, (2018) Inotropes and Vasopressors https://www.ncbi.nlm.nih.gov/books/NBK482411/
- Berry W, McKenzie C (2010) Inotropes and Vasopressors, Clinical Pharmacist, Vol. 2, p395 https://www.pharmaceutical-journal.com/download?ac=1065033

Analgesia and Sedation



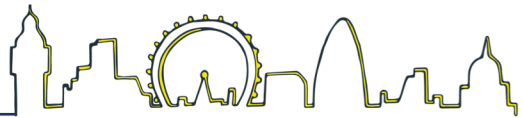
From the Intensive Care Society guidelines

- “Being ill in an ICU is nearly always very frightening and may require a number of painful or uncomfortable procedures”
- “The sedative regimen must be tailored to the individual patient, necessitating a multimodal and multidisciplinary approach and does not simply involve the use of drugs”
- “Adequate analgesia should be a fundamental part of this approach; sedation should never be given as a substitute for analgesia”

(www.ics.ac.uk)

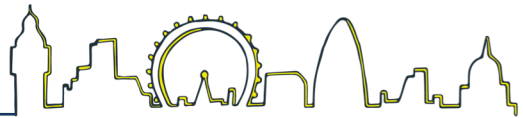
Indications (1)

- Fear and pain may cause increased sympathetic activity leading to hypertension, tachycardia and myocardial ischaemia. Pain may have other knock-on effects such as atelectasis
- Appropriate analgesia and sedation can reduce these effects, control agitation, and reduce consequent psychological trauma and Post-Traumatic Stress Disorder (PTSD) following discharge



Indications (2)

- Sedation may be needed to tolerate therapies such endotracheal tubes, abnormal ventilation and procedures.
- It is essential that adequate sedation is used for patients receiving paralysing medication
- Sedation may also be a treatment in its own right e.g., Seizure control, management of high intracranial pressure

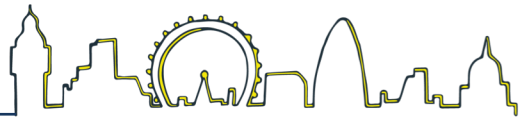


Problems

- An increase in delirium and gastric ileus
- Hypotension and under perfusion

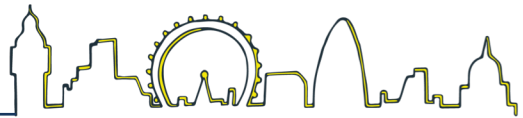
- Prolongation of artificial ventilation
- Delay in weaning from respiratory support

- Critical illness myopathy and muscle wasting
- Increased risk of nosocomial pneumonia, thrombosis and DVT



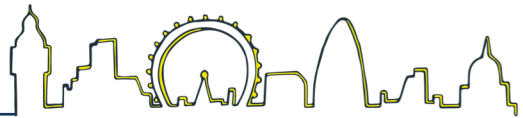
Commonly used IV medication

- Opioids – mainstay of analgesia in critical care, e.g. morphine, fentanyl
- Propofol – commonly used quick acting sedative
- Midazolam – short acting benzodiazepine
- Ketamine – sedative and analgesic properties
- Clonidine – analgesic, sedative and anxiolytic properties
- Dexmedetomidine – similar to, but more potent than clonidine



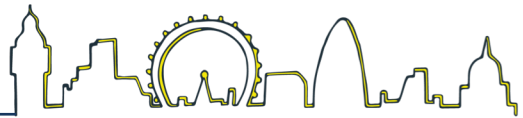
Morphine

- Archetypal opioid, not recommended as first line
- Peak analgesic effect within 20 min, peak respiratory depression within 7 minutes. Analgesia may be maintained up to 7 hours (www.drugs.com)
- Typical dose 1-10 mg/hr (unreferenced)
- Usual side effects of opioids
- Generally used as a continuous infusion in critical care – with a consequent possibility of unnoticed build-up of the medicine and intensification of side effects (accumulated in renal impairment)



Fentanyl

- Synthetic opioid, more potent than morphine
- Preferred analgesic agent for patients with hemodynamic instability
- Peak effect rapid, half life: 2-14 hours (emc). Fentanyl can accumulate in fat during prolonged use, leading to a longer half life
- Dose 6 mcg/kg/hr titrated to response, following bolus over 10 minutes (BNF). Lower to maintain spontaneous ventilation.



Other opioids

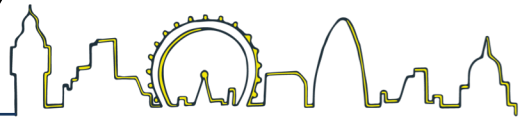
Both of these have a rapid onset

Alfentanil – less potent than fentanyl, and shorter duration of effect

- Initially 2 mg/hour, adjusted according to response; usual dose 0.5–10 mg/hour (BNF)

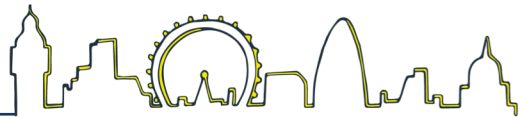
Remifentanil – slightly more potent than fentanyl, with a short half-life

- Initially 6–9 mcg/kg/hr. When titrating allow at least 5 minutes between dose adjustments (BNF)



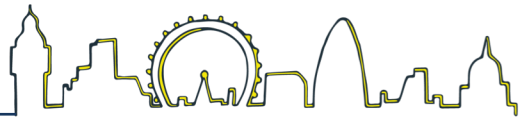
Propofol (1)

- Intravenous general anaesthetic agent that has sedative, hypnotic, anxiolytic and amnesic properties
- Rapid onset time
- Usual dose 0.3-4.0 mg/kg/hr (BNF)
- Available in two concentrations, 1% and 2%, with consequent rate change needed if swapping between them
- Hypotension and bradycardia are common side effects



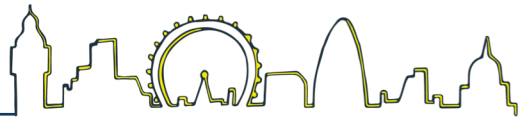
Propofol (2)

- Dissolved in lipid, and so high risk of causing bacteraemia if contaminated. Manufacturer recommends a single infusion of propofol must not exceed 12 hours
- Monitor lipids if used for over three days
- Caution if patient has egg, soya or nut allergies
- Prolonged infusions of > 4 mg/kg/hr can cause ‘propofol infusion syndrome’



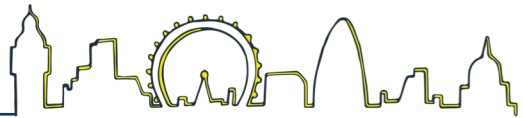
Midazolam

- (Relatively) short acting benzodiazepine
- Dose 30-200 mcg/kg/hr
- Rapid onset time 2-5 min, Elimination half life ranges from 3-5 hours
- Patients with impaired hepatic clearance and renal failure the elimination half life prolonged to 4-12 hours
- Associated with high risk of ICU delirium
- Common side effects are respiratory depression and hypotension



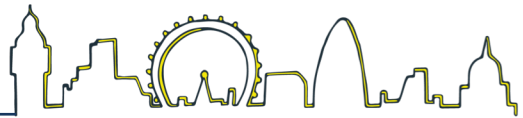
Ketamine

- NMDA receptor antagonist. Provides both sedation and analgesia
- Has a quick onset of action (30 sec) and is suitable for procedural sedation in the ICU
- Has bronchodilatory effects which is beneficial for asthmatic patients
- The dose varies by indication
- Common side effects include increase intracranial pressure, increased oral secretions, vivid dreams and hallucinations



Clonidine

- A centrally acting α_2-agonist which has analgesic, sedative and anxiolytic properties
- Provides sedation with minimal respiratory depression (not licensed for sedation)
- It is effective to control delirium and withdrawal syndrome caused by opioids, benzodiazepines, alcohol and nicotine
- Dose 0.5 – 2 mcg/kg/hr (unreferenced)
- Can cause hypotension (it is used as an antihypertensive)
- Sudden cessation can cause agitation, sweating and hypertension

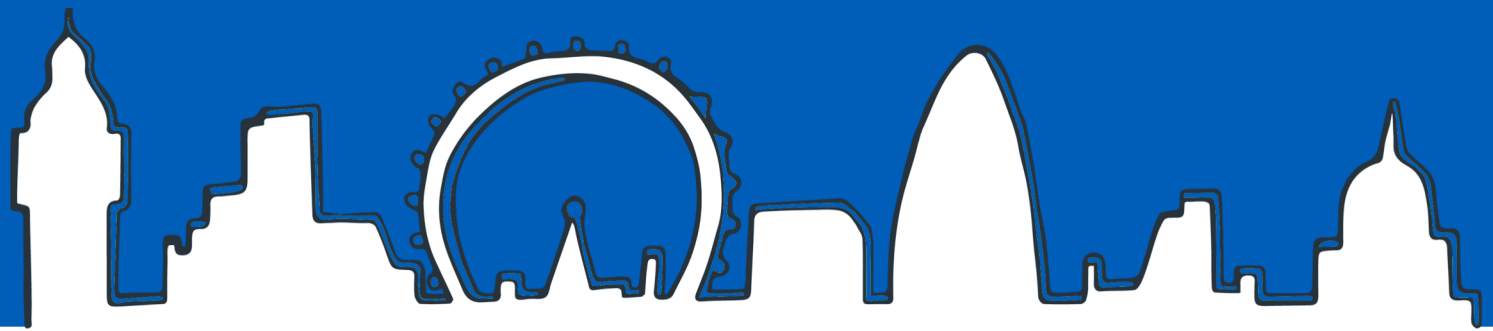


Dexmedetomidine

- An α_2-agonist with analgesic, sedative and anxiolytic properties. More potent than clonidine.
- May have a role in treatment of ICU delirium
- Dose 0.2 to 1.4 mcg/kg/hr (emc). Suggested start 0.7 mcg/kg/min for intubated and ventilated patients, lower for frail patients. Do not exceed max.
- Elimination half life ~2 hours (emc)
- Reduce the dose gradually to avoid withdrawal symptoms
- Common adverse effects are hypertension and arrhythmias

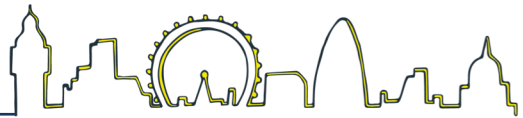
Paralysing agents

(Neuro-Muscular Blocking Agents)



Neuro-Muscular Blocking Agents

- These paralyse skeletal muscles by blocking the transmission of nerve impulses at the neuromuscular junction
- They are used to facilitate intubation, promote ventilator synchrony, to control increased intra-cranial pressure and to decrease work of breathing
- It is absolutely essential to ensure your patient is adequately sedated whilst receiving an NMBA
- Shorter acting agents are generally preferable
- Prolonged use is associated with prolonged mechanical ventilation, delayed awakening, residual muscular weakness and critical illness myopathy



Suxamethonium

- Depolarising NMBA – Binds to cholinergic receptors causing initial depolarisation followed by blockade of neuromuscular transmission.
- Dose 1-1.5 mg/kg (BNF)
- Usually produces muscular relaxation in about 30 – 60 seconds with duration of action about 2 – 6 minutes (emc)
- Significant possible side effects are malignant hyperthermia and hyperkalemia
- Don’t use in patients with increased intracranial pressure

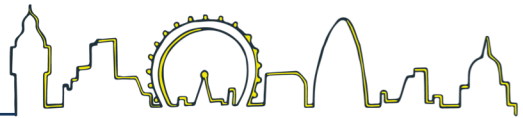
Non-depolarising NMBAs

Rocuronium – rapid onset of 1-2 min; for RSI, 1 mg/kg (emc)

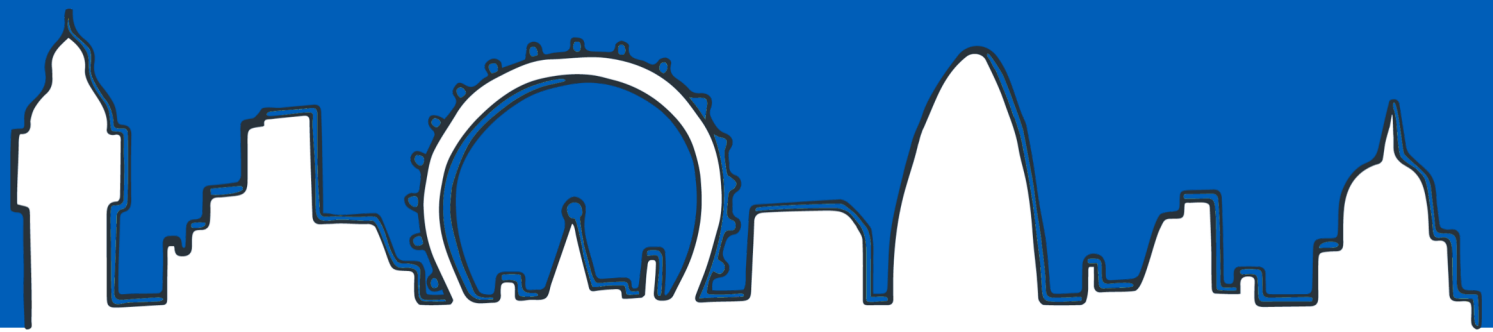
Atracurium – intermediate acting, causes histamine release (can lead to hypotension), bolus dose 0.5 – 0.6 mg/kg (emc)

Pancuronium – Long acting NMBA with vagolytic properties; not recommended to be used by infusion

Train of four (ToF) monitoring is used for continuous infusion of NMBA



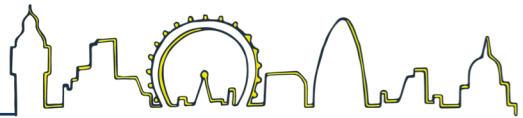
Rapid Sequence Intubation (RSI)



RSI pharmacology

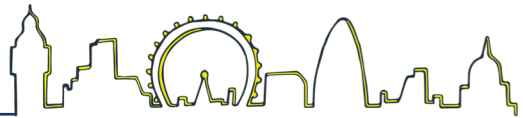
RSI is an airway management technique that induces immediate unresponsiveness and muscular relaxation and is the fastest and most effective means of controlling the emergency airway (LITF). Uses:

- Induction agent – e.g. Propofol, Etomidate, Ketamine
- NMBA – e.g. Suxamethonium, Rocuronium
- Also generally uses a third drug to reduce the CVS effects of airway manipulation – e.g. Fentanyl, β-blocker, lidocaine

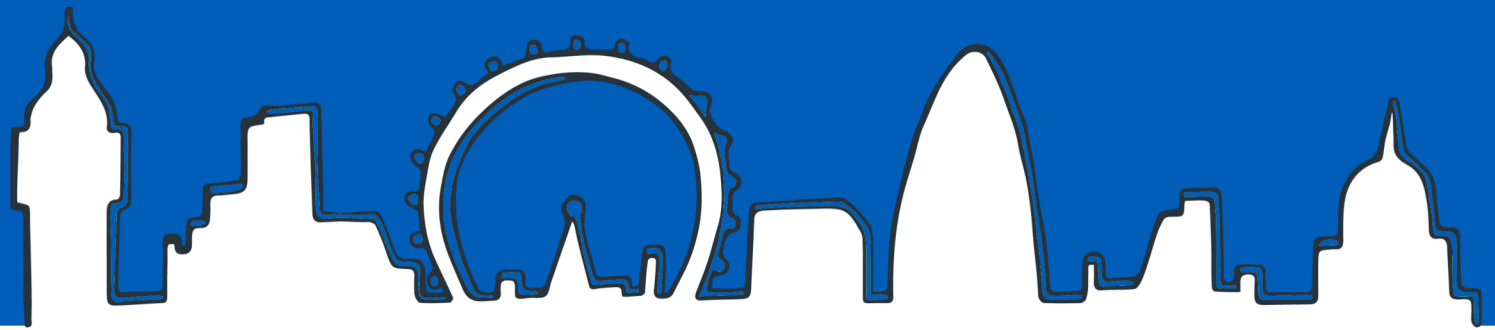


Induction agents

- Induction agents provide amnesia and reduce sympathetic responses
- If a paralysing agent was used without sedation, the patient would be fully aware of environment including pain but unable to respond
- Ketamine – Used for patient in severe asthma to reduce bronchospasm
- Etomidate – Acts on GABA receptors and blocks neuro excitation. Used for patient with haemodynamic instability
- Propofol – Widely used in critical care, used for patients with high intracranial pressure

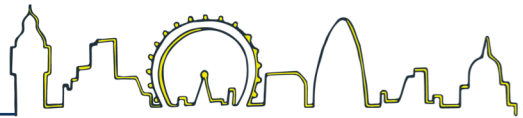


Electrolytes



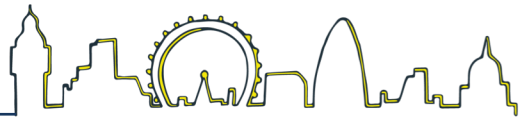
Problems caused by low/high levels of electrolytes

- High, or low, levels of different electrolytes can cause multiple different problems.
- Some of the most common in critical care are:
  - Low potassium or magnesium, which can make a patient prone to dysrhythmias (including VF)
  - High potassium, which can also cause dysrhythmias (including asystole).



Electrolytes

- When supplementing electrolytes a target range other than the normal physiological range is often used in Critical Care. This is because critical care patients are more sensitive to derangement and at a greater risk of instability (arrhythmias).
- Intravenous electrolyte replacement therapy is indicated [rather than enteral] if the patient:
  - Has severely low levels
  - Is symptomatic.
  - Or is unlikely to absorb oral agents.



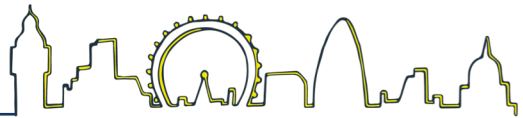
Electrolytes (NB follow local policy)

Potassium:

- Normal range: 3.5 – 5.9 mmol/L
- (aim 4.0 - 4.5 in ICU)

Phosphate (PO_4)

- Normal range: 0.8–1.5 mmol/L
- (NB polyfusor phosphate has high sodium content, and addiphos has high potassium content)



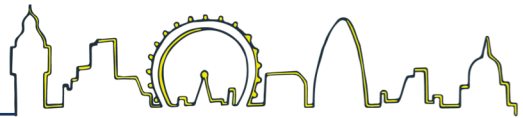
Electrolytes (NB follow local policy)

Calcium:

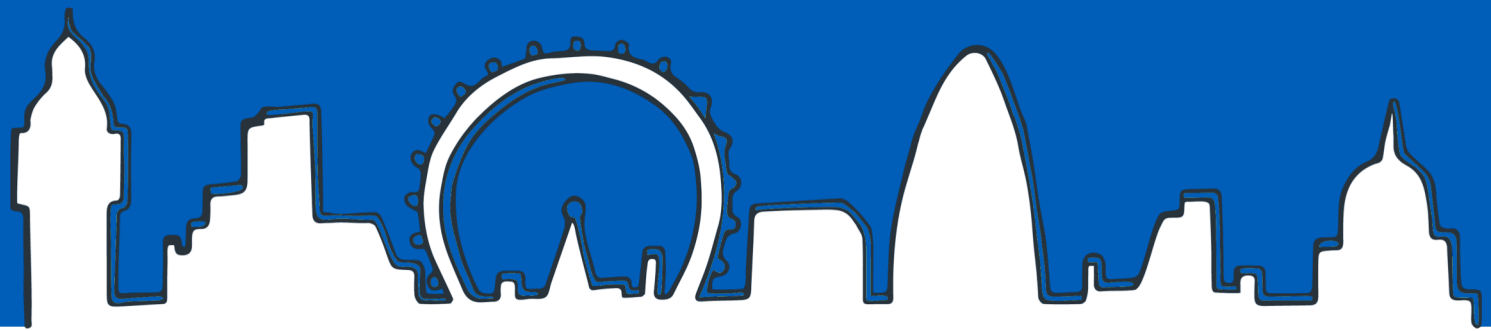
- Corrected Ca – normal range 2.05 to 2.60 mmol/l
- In Critical Care typically maintain corrected Calcium at 2.1 – 2.6 mmol/L, or
- Ionised Calcium > 1.0 mmol/L

Magnesium:

- Normal range 0.7 – 1.0 mmol/L (total magnesium).
- Some ABG machines will also measure ionised Mg – normal range is 0.44 to 0.59



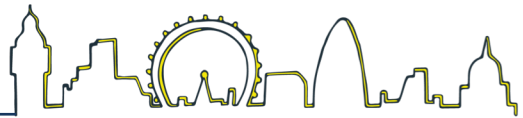
Antiarrhythmic drugs – Amiodarone



Amiodarone

Amiodarone is indicated for the treatment of serious cardiac arrhythmias, in cases where other therapies are not effective or contraindicated:

- Atrial arrhythmias, including atrial fibrillation or flutter
- AV nodal arrhythmias and AV re-entrant tachycardia.
- Life-threatening ventricular arrhythmias, including persistent or non-persistent ventricular tachycardia or episodes of ventricular fibrillation



Amiodarone – Dose

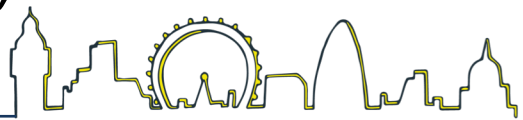
Loading dose

Many units use 300 mg over one hour.

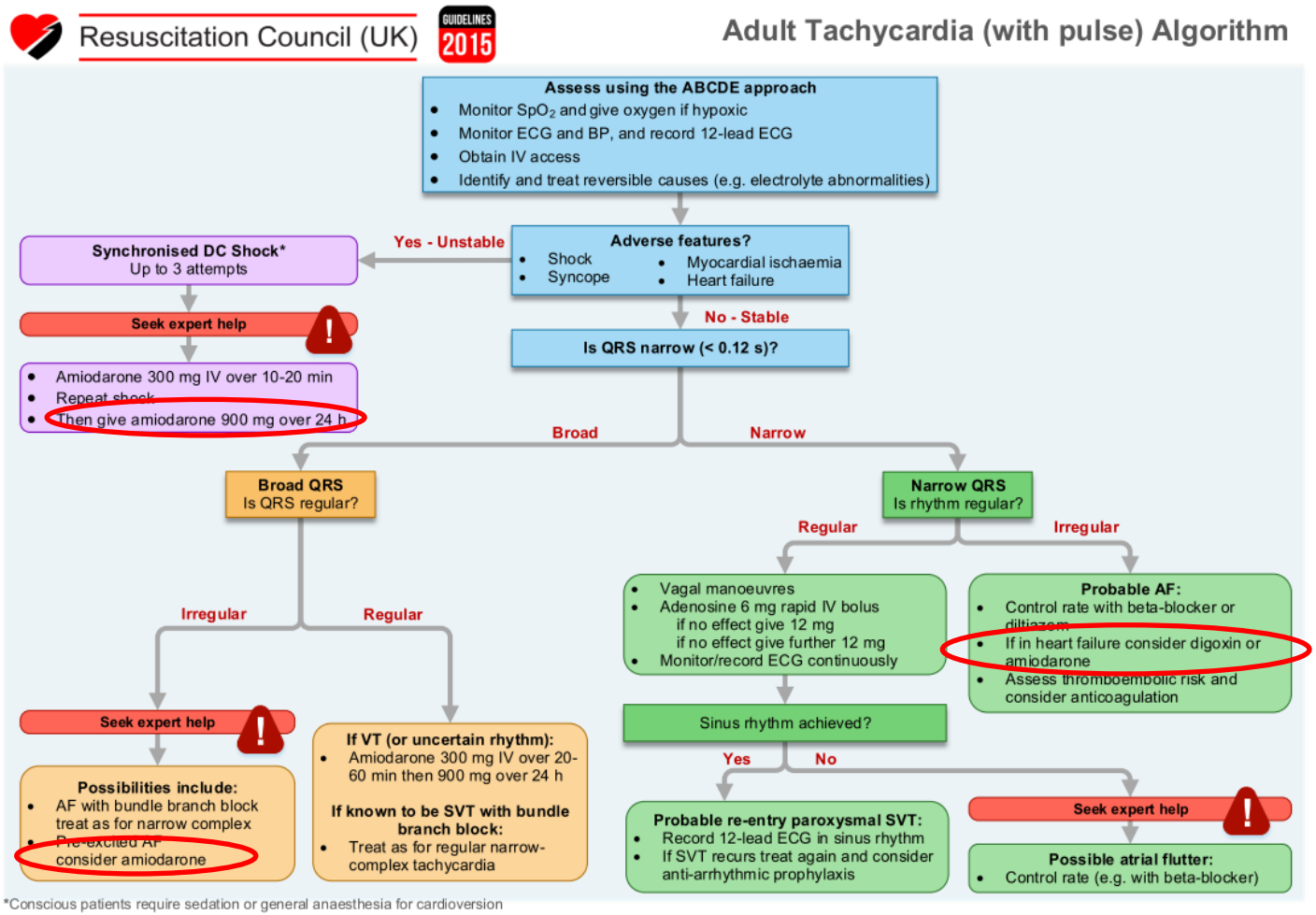
Or: 5 mg / kg, over 20 minutes to 2 hours (BNF)

Extreme clinical emergency

Give as a slow injection of 150-300mg in 10-20ml 5% glucose over a minimum of 3 minutes. This should not be repeated for at least 15 minutes (emc).



ALS context


Resuscitation Council (UK)
GUIDELINES 2015
Adult Tachycardia (with pulse) Algorithm
Assess using the ABCDE approach
Monitor SpO2 and give oxygen if hypoxic
Monitor ECG and BP, and record 12-lead ECG
Obtain IV access
Identify and treat reversible causes (e.g. electrolyte abnormalities)
Adverse features?
Shock
Syncope
Myocardial ischaemia
Heart failure
Yes - Unstable
Synchronised DC Shock*
Up to 3 attempts
Seek expert help
Amiodarone 300 mg IV over 10-20 min
Repeat shock
Then give amiodarone 900 mg over 24 h
No - Stable
Is QRS narrow (< 0.12 s)?
Broad
Narrow
Broad QRS
Is QRS regular?
Irregular
Regular
Seek expert help
Possibilities include:
AF with bundle branch block treat as for narrow complex
Pre-excited AF consider amiodarone
If VT (or uncertain rhythm):
Amiodarone 300 mg IV over 20-60 min then 900 mg over 24 h
If known to be SVT with bundle branch block:
Treat as for regular narrow-complex tachycardia
Narrow QRS
Is rhythm regular?
Regular
Irregular
Vagal manoeuvres
Adenosine 6 mg rapid IV bolus
if no effect give 12 mg
if no effect give further 12 mg
Monitor/record ECG continuously
Probable AF:
Control rate with beta-blocker or diltiazem
If in heart failure consider digoxin or amiodarone
Assess thromboembolic risk and consider anticoagulation
Sinus rhythm achieved?
Yes
No
Probable re-entry paroxysmal SVT:
Record 12-lead ECG in sinus rhythm
If SVT recurs treat again and consider anti-arrhythmic prophylaxis
Seek expert help
Possible atrial flutter:
Control rate (e.g. with beta-blocker)
*Conscious patients require sedation or general anaesthesia for cardioversion

Amiodarone – administration

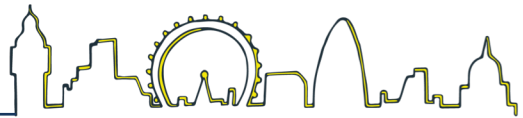
Should only be used under continuous monitoring (ECG and BP).

Incompatible with saline – use 5% Glucose.

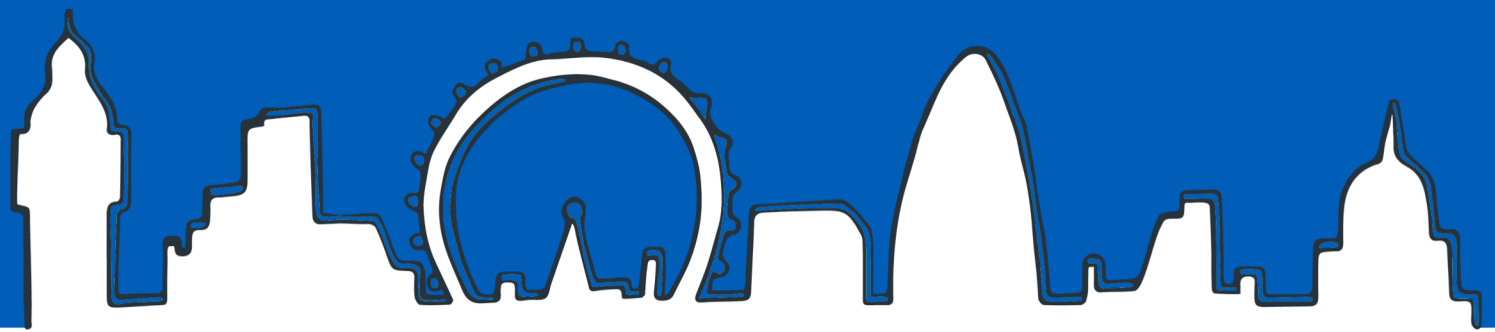
Do not use concentrations below 300 mg per 500 ml on account of the stability of the solution, and don’t add other drugs to the infusion fluid.

Circulatory collapse may be precipitated by too rapid administration or overdosage – IV infusion is preferred to bolus.

Repeated or continuous infusion via peripheral veins may lead to injection site reactions. When this is anticipated, use central access.

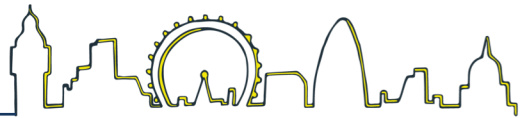


Other



Insulin and glucose for Hyperkalaemia

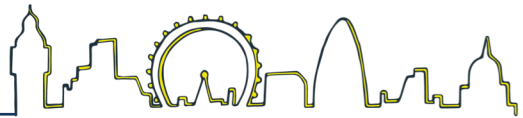
- Insulin drives potassium into cells, and administering glucose prevents hypoglycaemia.
- **Example** dose: Actrapid 10 units and 50% glucose 50 ml
- Begins to work in 20-30 mins, reduces potassium by 1 mmol/L and ECG changes within the first hour.



Furosemide

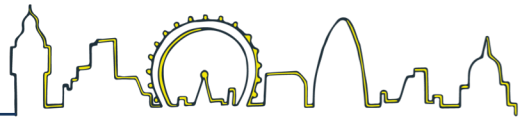
- High doses or rapid intravenous administration can cause tinnitus and deafness.
- Intravenous administration rate should not exceed 4 mg/minute.
- Single doses of up to 80 mg may be administered more rapidly; a lower rate of infusion may be necessary in renal impairment.

(BNF)



Drug level monitoring

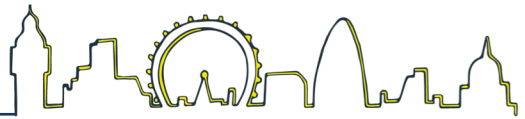
- For some drugs, a standard dose will result in very different blood levels in different people.
- This is particularly true for critically ill patients.
- To titrate the dose of these drugs it may be necessary to check the blood levels and make sure these are not too high, too low or both.
- Examples where levels need monitoring are: gentamicin, vancomycin, amikacin, phenytoin, digoxin, valproate, aminophylline



Drug level monitoring – example – Gentamicin

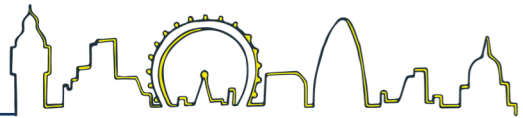
- For patients on the once daily gentamicin regimen, trough levels can be taken up to 6 hours before the next dose is due (or according to local guidelines). Trough level should be below 1mg/L.
- It is vital antibiotic doses are not missed, and *generally* doses should not be held to wait for a level unless renal toxicity is suspected.

(the above may need to change if a patient has known or possible renal impairment).



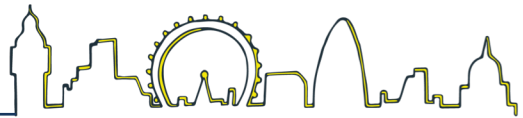
Heparin

- Heparin enhances the natural process of inactivating coagulation factors, and so prevents clots forming. It does not break down clots that have already formed.
- What is normally referred to as heparin is more properly referred to as ‘unfractionated heparin’ (UFH)



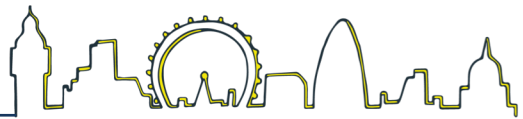
Heparin – titrating dose and stopping

- Monitor the anticoagulant effect of heparin using the APTTR (Activated Partial Thromboplastin Time Ratio).
- Heparin dosing is complex, and local policies should **always** be followed.
- After changing the infusion rate, you should always wait for a period of time (follow local policy – typically 4 to 6 hours) for the change to have its full effect before rechecking the clotting.
- After turning off, it is necessary to wait for the effect to wear off before e.g. surgery



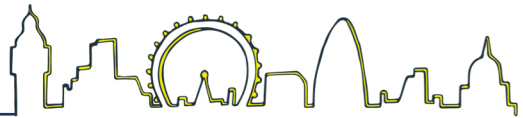
Heparin – reversal

- The effects of heparin can be reversed using protamine.
- Dosage is complex, and specialist advice is needed (overdosing on protamine can make clotting even worse).



Insulin

- Many different forms of insulin are available
- Critical Care units will most commonly use a short acting insulin (aka soluble insulin). NB Actrapid is a trade name.
- Insulin should **always** be drawn up in an insulin syringe (NPSA alert).
- Blood samples used to check glucose levels should not come from a line containing glucose (NPSA alert).
- Blood glucose can change rapidly and unpredictably in critically ill patients
- Generally advised to always have a source of glucose running if an insulin infusion is in progress

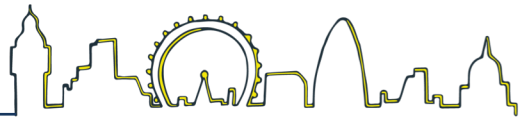


Vancomycin – safety issues

- Careful consideration of whether intermittent infusion or continuous infusion has been prescribed
- Consider when levels will be needed
- Potential for renal damage
- Consider rate of infusion, not more than 10 mg/min to avoid ‘red man’ syndrome
- Rapid IV injection can cause cardiac arrest or cardiogenic shock

‘Human factors’

- ‘Human factors’ are frequently quoted as an underlying cause of medication errors.
- Errors are more frequent in stressful situations
- Personal situations are also risk factors: e.g. if you are Hungry, Angry, Late or Tired, you are at higher risk than normal of making a medication error, and should HALT



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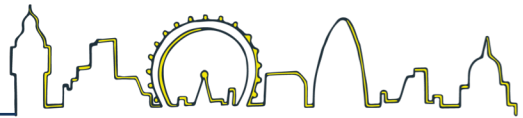
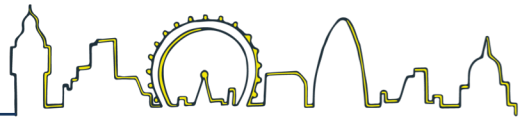
capitalnurse@hee.nhs.uk



Useful reference sources

- BNF (www.bnf.nice.org.uk)
- The Electronic Medicines Compendium (emc) (www.medicines.org.uk)
- Many trusts subscribe to Medusa (http://www.injguide.nhs.uk/)



Other reference sources

Intensive Care Society standard concentrations:
https://www.ics.ac.uk/AsiCommon/Controls/BSA/Downloader.aspx?iDocumentStorageKey=869e97f4-fa26-416a-b1e8-e4904b251fac&iFileTypeCode=PDF&iFileName=Medication Concentration in Critical Care Areas

Thames Valley Y-site IV drug Compatibility chart:

http://medusa.wales.nhs.uk/Docs/TVCCN%20IV%20Compatibility%20Chart%20v2.1.pdf

UKCPA minimum infusion volumes:

http://ukclinicalpharmacy.org/wp-content/uploads/2017/07/Minimum-infusion-volumes-2012.pdf